Space Weather Technical Forecast

Issued on Wednesday, 22 June 2022 at 01:29 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Active electron fluence likely Day 1 (22nd). Daily Chance of an isolated M-class flare.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with occasional C-class flares. There are presently six numbered sunspot regions and one new region on the visible disc. The largest and most complex region remains AR3038 (Eki/Beta-Gamma) transiting across the northwestern quadrant. This region has continued to mature, becoming more elongated whilst retaining large leading and trailing spots, with some further intermediate spot emergence. R3035 (Cri/Beta) has developed rudimentary penumbra around the leader portion of the spot. AR3030 continues to transit around the northwest limb, though it is disappearing from view, it's analysis remains unchanged.

No Earth directed CMEs (Coronal Mass Ejections) were observed on available imagery. Some imagery suggests a CME being emitted from the southwest limb late on 21st June, though further imagery is necessary before an analysis takes place.

Solar Wind / Geomagnetic Activity: The solar wind speed, as measured by DSCOVR at L1, has fluctuated between 450-550 km/s throughout the past 24 hours. Its density was largely average but a brief peak was observed to around 20 ppcc near 21/0900 UTC. The IMF was generally weak 1-7 nT, with Bz varying between +5 and -6nT. The phi angle was mostly positive (away from the Sun) initially, but became largely negative (towards the Sun) after 21/0900 UTC. Geomagnetic activity was generally Quiet (Kp 1-2) with two Unsettled (Kp 3) intervals.

Energetic Particles / Solar Radiation: The high energy proton flux (10 MeV) measured by GOES16 remained at background levels through the period. Electron flux (greater than 2MeV) was generally at Moderate to High levels in the period, with a peak of 2260pfu observed at GOES16 at 21/1515 UTC. The corresponding 24-hour integrated electron fluence has been on a gradual declining trend falling below the Active threshold (>1e8 integrated pfu) by 21.1200 UTC. Observed fluence was 8.48e8 integrated pfu at 22/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to be Low, with a daily chance of an isolated M-class flare and very slight chance of an X-flare.

Solar Wind / Geomagnetic Activity: No CMEs currently feature in the forecast. Though one potential CME from the southwest limb is yet to be analysed.

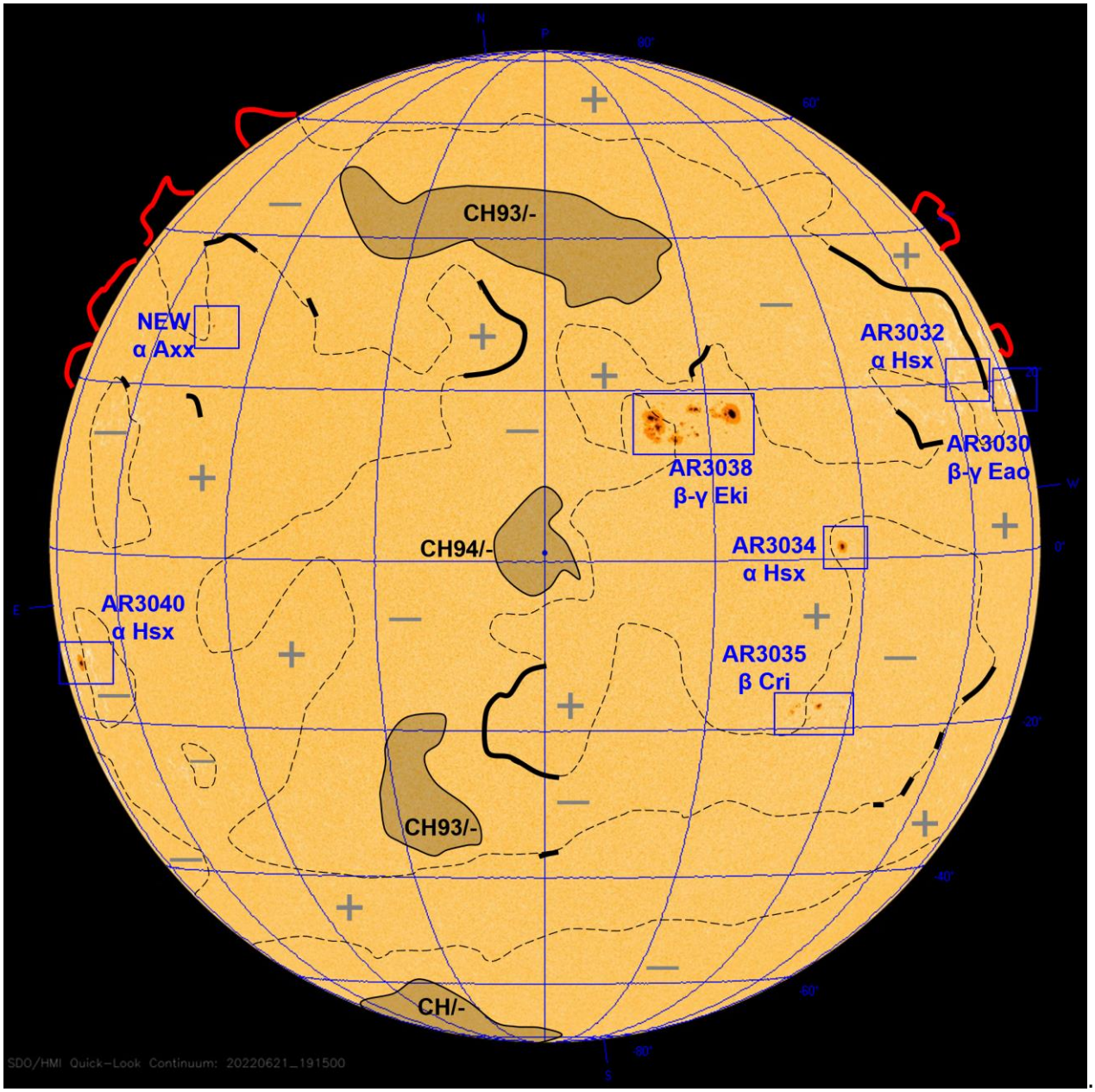
Solar winds should continue their initial decline and return towards slow-ambient levels by Day 2 (23rd). Winds are expected to become slightly elevated to elevated during Day 3 and Day 4 (24th/25th), under the influence of coronal hole high speed streams from CH93/- then followed by CH94/-. Geomagnetic activity should be mostly Quiet with perhaps the odd Unsettled interval through the first half of the period, but become Unsettled to Active with a slight chance of a G1/Minor storm during Days 3 and 4 (24th/25th).

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10 MeV) is expected to be at Background levels during the period, but with a daily Slight Chance of an S1 or greater event. The high energy electron flux (greater than 2 MeV) is expected to gradually decline to Background to Moderate levels by Day 3, though perhaps with daily peaks into High during the diurnal max on days 1 and 2 (22nd and 23rd). The associated 24-hour integrated fluence is expected to continue on a steady or downward trend below the Active threshold throughout.

Figure 1. Solar Analysis Valid 21/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Geomagnetic Storms:

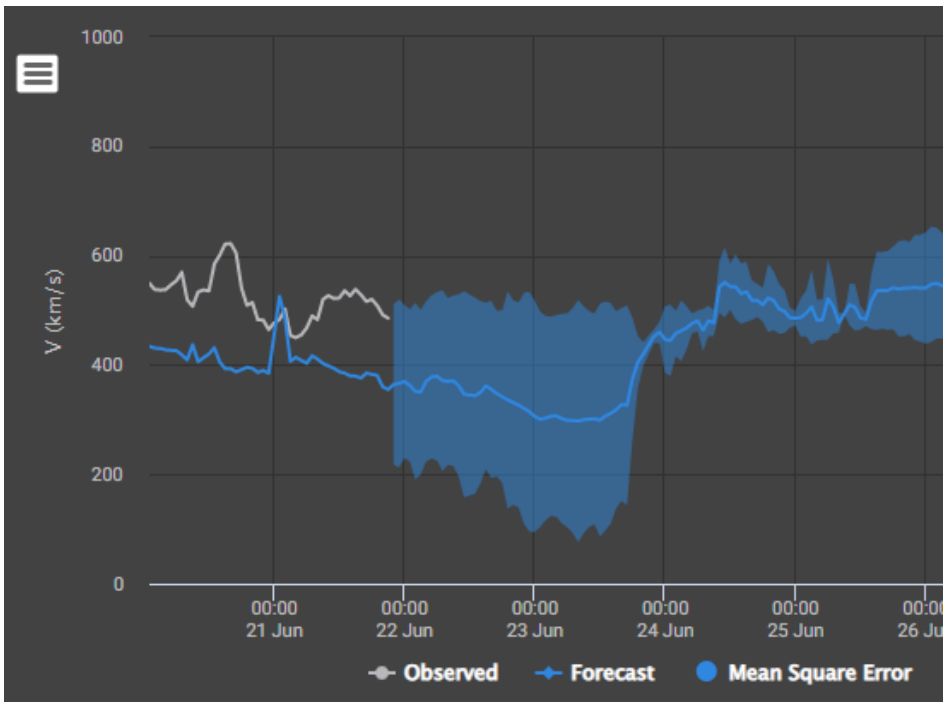
No CMEs currently feature in the forecast, though initial imagery indicates a possible CME which left the southwest limb late on 21st UTC. We are awaiting further imagery before a full analysis can take place.

The Earth has been encountering slightly elevated to elevated wind speeds throughout the past two days. Solar winds should continue their initial decline and return towards slow-ambient levels through 22nd or 23rd June before encountering the HSS of CH93/- on 24th June. This is shortly followed by another coronal hole (CH94/-), which is most likely to arrive on 25th June.

With this in mind, geomagnetic activity should be mostly Quiet with perhaps the odd Unsettled interval through the first two days (22nds and 23rd), but become Unsettled to Active with a slight chance of a G1/Minor storm during the second half of the period (24th and 25th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	5	10	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: Space Weatehr Prediction Model showing trend of solar winds speeds over next 4 days



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Radio Blackouts - X-Ray Flares:

There are seven sunspot regions on the visible disc at present. The largest and most complex region remains AR3038 (Eki/Beta-Gamma) transiting across the northwestern quadrant. This region is contributing the greatest proportion of risk for both M and X-class flares through the period, although there are two spots AR3030 and ex-AR3031 which are on or just around the western limb. These two spots have shown some recent flare activity and were both of moderate size and complexity when in visible positions on the earth facing disk. AR3030 remains included in the calculations for M-class flares for the next 12-24 hours, but its exit from the northwest limb will reduce probabilities by day 2.

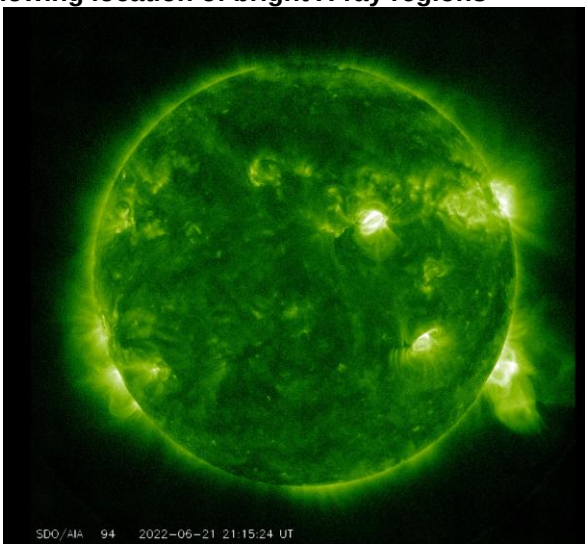
AR3035 in the southwest is currently becoming a little more complex though remains classed as a Cri beta at present. All other sunspot regions remain small and simple.

Solar activity has been Low over the past 24 hours, with occasional C-class flares. Activity is likely to continue at Low levels, with a chance of an isolated M-class flare, and slight chance of an X-flare, most likely from AR3038.

There are several moderately large filaments present on the disk, though all appear to be stable at present so will be monitored for any potential lift-off. Some further bright flux regions are also visible on STEREO A EUVI195 imagery, close to the eastern limb, suggesting the presence of sunspots regions. These could potentially emerge from the far side over the next couple of days, leading to a readjustment of the probabilities.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	40	30	30	20
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3:SDO 94 imagery showing location of bright X-ray regions



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is currently at background levels and is expected to remain at this level through the period. However, there is a slight chance of an S1 or greater event through the next four days as AR3038 rotates across the western disc. This region is relatively large, complex with some further development. As such, it carries a slightly elevated risk of solar radiation storm.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

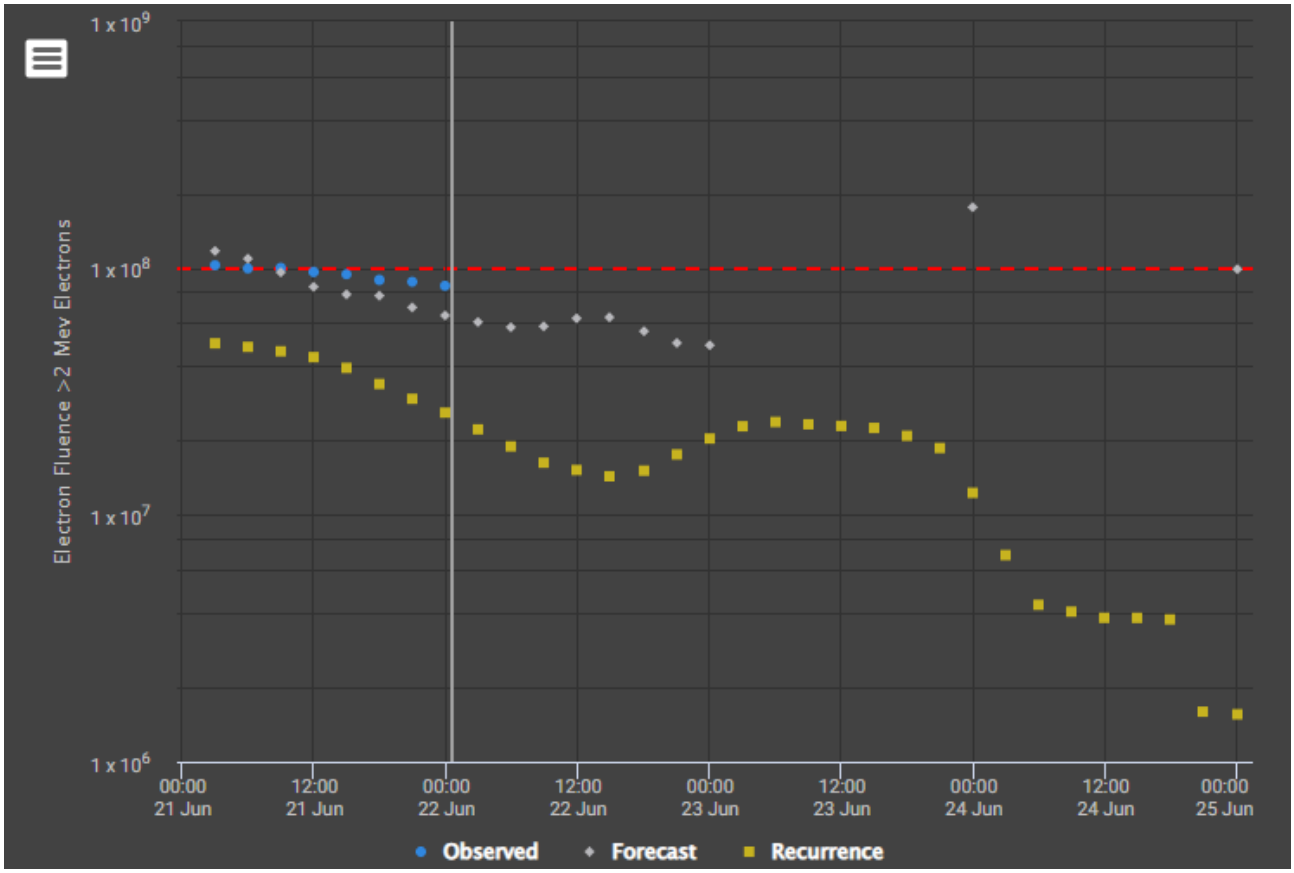
© Crown Copyright 2022. All Rights Reserved.

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2 MeV) is expected to gradually decline to Background to Moderate levels through the period, though days 1 and 2 may see the diurnal peak briefly breach the High threshold. By Day 3, with the onset of CH93/-, electrons are expected to become suppressed with the risk of reaching the High threshold falling considerably. The associated 24-hour integrated fluence is expected to continue on a steady or downward trend below the 1e8 Active threshold throughout.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	Yes	40	30	10	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	5	2	1	1

Figure 4: REFM model showing recurraance, forecast and observed fluence



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2022. All Rights Reserved.